(12) UK Patent Application (19) GB (11) 2 325 883 (13) A

(43) Date of A Publication 09.12.1998

(21) Application No 9711469.8

(22) Date of Filing 03.06.1997

(71) Applicant(s)
De La Rue International Limited
(Incorporated in the United Kingdom)
6 Agar Street, LONDON, WC2N 4DE, United Kingdom

(72) Inventor(s)
Malcolm Robert Murray Knight
Duncan Hamilton Reid
Robin Bratchley
Andrew Nutton

(74) Agent and/or Address for Service
Boult Wade Tennant
27 Furnival Street, LONDON, EC4A 1PQ,
United Kingdom

(51) INT CL[6]
B42D 15/00 , D21H 21/42

(52) UK CL (Edition P)
B6A AC41 AC52 ATC

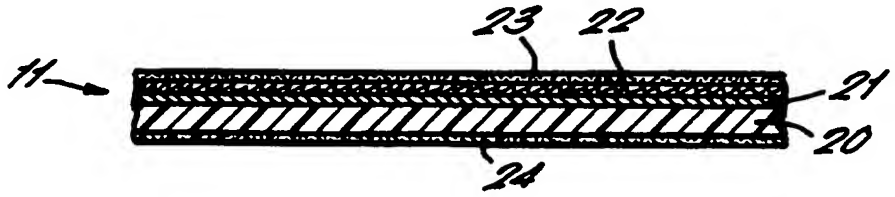
(56) Documents Cited
US 4941687 A

(58) Field of Search
UK CL (Edition O) **B6A ATC**
INT CL[6] **B42D 15/00**
Online databases: WPI

(54) Abstract Title
A windowed security thread having a matt non-reflective surface

(57) The part of the security thread exposed in the window has a matt non-reflective appearance and closely matches in colour a portion of the surface surrounding the window, whereby when the thread is viewed in reflected light in the visible spectrum the exposed part of the security thread is unobtrusive. The thread 11 may comprise a substrate 20 with a metallic layer 21 covered by a matt pale yellow coating 22, the yellow coating comprising a luminescent material.

FIG. 5.



GB 2 325 883

FIG. 1.

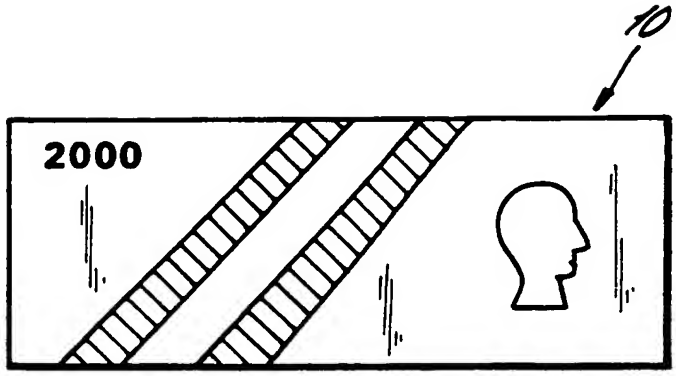


FIG. 2.

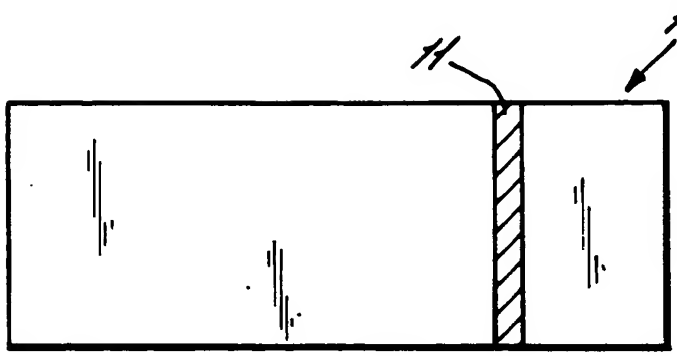


FIG. 3.

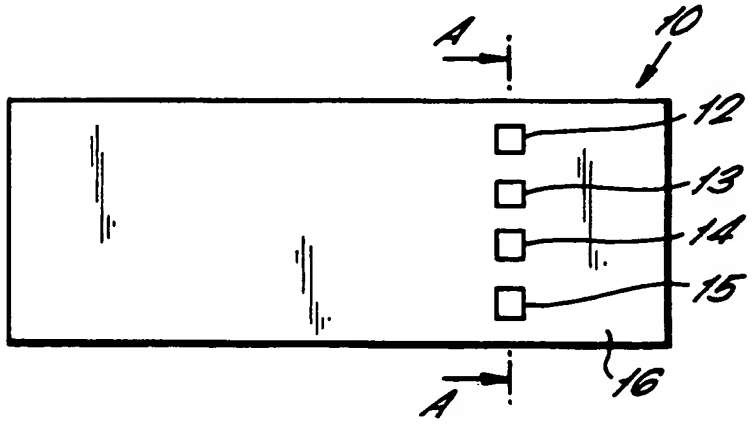


FIG. 4.

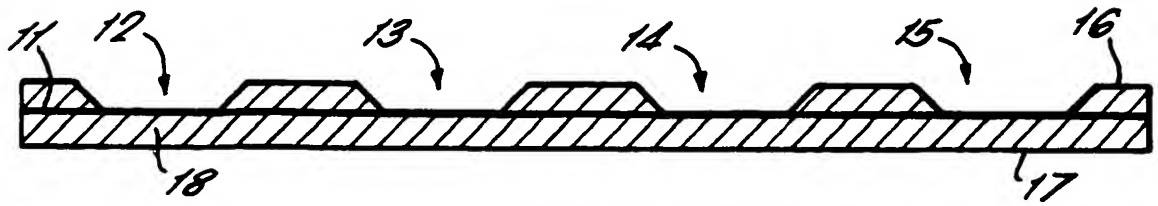


FIG. 5.

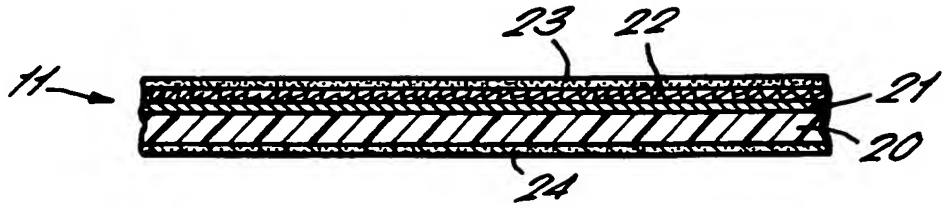


FIG. 6.

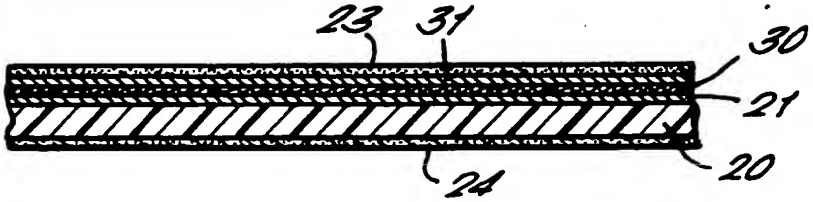


FIG. 7.

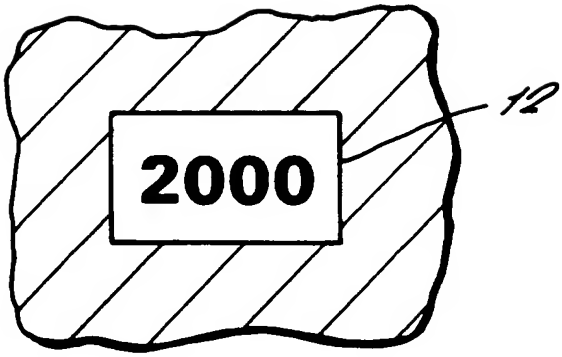
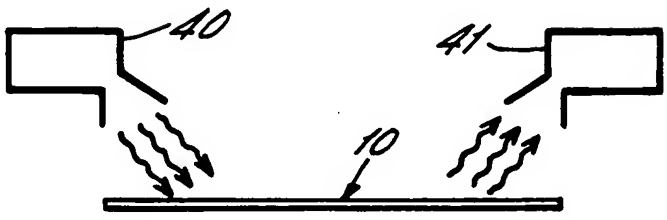


FIG. 8.



2325883

A SECURITY ARTICLE, A METHOD AND MANUFACTURE OF THE SECURITY ARTICLE, A METHOD OF VERIFYING AUTHENTICITY OF THE SECURITY ARTICLE AND SECURITY PAPER

The invention is concerned with security articles such as cheque guarantee cards, identification cards and the like and such as security paper including bank notes, cheques and the like. The present invention also relates to a method of manufacture of security articles and a method of verifying the authenticity of the security article.

It is widely known to use in banknotes security threads which are made from a transparent film provided with a continuous reflective metal layer, vacuum deposited aluminium on polyester film being the commonest example. Banknotes made from such paper have been in general circulation in many countries for many years. British patent specification nos. GB-A-1552853 and GB-A-1604463 describe use of a security thread in a security paper with the thread exposed on one side of the security paper at intervals along the length of the thread, the regions of exposure being referred to as windows. The original purpose of providing windows was to produce a strong public security feature (i.e., a security feature readily identified by the general public) which presented a sharp contrast in appearance when viewed in reflected light as opposed to when viewed in transmitted light. In reflected light the security thread appeared as a continuous dark line. In contrast, in reflected light, the portions of the thread visible at the windows appeared silver. Furthermore, the windowed thread provided good protection against photocopying because when a bank note with windowed thread is photocopied, the reflective silver surfaces appearing in the windows

appear black in the photocopy, because of the reflected light.

Further to the original window thread design, improved more complex versions have been produced. For instance, threads have been produced which are laminates of two metallised polyester plies with magnetic material incorporated between them. Some threads have been produced which are in parts demetallised, so that alphanumeric characters, for instance, can be viewed on the thread in transmitted light. Some threads have been produced which change colour with temperature. Some security threads have been produced which have holographic images. Some security threads have been produced which fluoresce under ultra-violet or infra-red light and some of these threads have been produced with alphanumeric characters shown by demetallised portions.

With all of the windowed thread designs produced to date the aim of incorporating the windowed thread in the bank note was to present a highly reflective image in regions on one face of the bank note, this image being a very noticeable public security feature and also a feature to prevent photocopying.

The applicants have appreciated that the strong public perception of windowed security threads can in some cases be a problem. As bank note sizes are reduced on cost grounds there is an increasing pressure on space. Bank note printers often wish to incorporate complex print designs on a note surface but are limited by the strong reflected light appearance of the windowed security thread. Often notes now have holograms/foils applied to their surfaces and designers of bank notes are increasingly reluctant to make provision for a second reflective element on the surface, i.e., the windowed security thread.

The present invention provides a security article

having first and second surfaces and a security thread having a first part located between the first and second surfaces and a second part exposed in a window provided in the first surface, the security thread comprising means providing at least one non- public security feature which enables verification of authenticity of the security article and which is not visually detectable when the security thread is exposed only to electro-magnetic radiation in the visible spectrum, wherein the exposure of the second part of the security thread in the window on the first surface enhances detection of the non-public security feature by providing a readily accessible portion of the security thread, characterised in that the whole of the part of the security thread exposed in the window in the first surface has a matt non-reflective appearance and closely matches in colour a portion of the first surface surrounding the window, whereby when the first surface is viewed in reflected light in the visible spectrum the exposed part of the security thread is unobtrusive and does not form a visually striking feature of the appearance of the security article in reflected light in the visible spectrum.

The present invention has departed from accepted teaching by providing a windowed thread which is not a readily apparent public security feature in reflected light. Since the windowed thread is not readily apparent in reflected light, it does not provide the protection against photocopying which was a prime aim of the previous windowed threads. The non-public security feature could be a feature for recognition by a trained inspector or cashier, e.g. using ultra-violet light.

Preferably the non-public security feature is a machine-measurable security feature and the exposure of the second part of the security thread in the window enhances measurement of the machine-measurable

security feature.

The applicants have realised that there is merit in providing a windowed thread, even when the windowed thread is not intended to provide a public security feature in reflected light. The applicants have appreciated that the use of a windowed thread is advantageous in presenting a machine-readable element on the surface of, for instance, a bank note, where the security thread is readily accessible to an appropriate detector. In the past, where security threads have not been visible in reflected light, they have been embedded totally within a bank note and then machine-readable features included in the security thread. For instance, use of a machine-readable luminescent layer on a magnetic thread is disclosed in GB-A-1585533, on fully embedded thread. However, the full embedding of the threads means that the embedded threads are covered with fibres and this makes it more difficult for machine authentication of the luminescent contents to occur. There is a great practical advantage in using a windowed thread to provide an area on the surface of, for instance, a bank note which can be readily accessed by a machine detector.

Preferably the security article comprises material which allows transmission of light between the first and second surfaces and the security thread is visible in such transmitted light.

Thus, the thread of the present invention can be seen in the security article as an immediately apparent strong continuous line in transmitted light.

In an alternative embodiment the security article again comprises material which allows transmission of light between the first and second surfaces, but the security thread is nearly transparent and is not readily visible in transmitted light.

The non-public security feature could be detected

by exposing the second exposed part of the security thread to electromagnetic radiation outside of the visible spectrum. The detection could be facilitated by the security thread emitting electromagnetic radiation on exposure to the non-visible electromagnetic radiation. The emitted radiation could be electromagnetic radiation in the visible region of the electromagnetic spectrum.

Preferably the surface of the security thread exposed in the window has a gloss of 50 units or less as measured by a Novo-Gloss 60° glossmeter. Additionally, or alternatively, a multi-angle Novo-Gloss glossmeter could be used to measure the gloss, in which case the measured gloss would preferably be 10 units or less at 20°, 50 units or less at 60° and 120 units or less at 75°.

Preferably the surface of the security thread exposed in the window has a specular reflectance of 5.0% or less as measured by a Shimadzu UV3101-PC spectrophotometer operating in a range of 400-700nm of electromagnetic radiation.

Preferably the security article of the present invention has a security thread which comprises a metallised polymeric substrate coated at least in the exposed portion with a matt coating obscuring the metal in the thread. The matt coating renders the thread substantially non-reflective. Preferably the metallised polymeric substrate is opaque.

In one embodiment the matt coating on the thread is luminescent and provides the non-public security feature of the security thread by emitting measurable light when exposed to ultra-violet radiation. In this embodiment a metallised polyester thread could be covered with a matt pale yellow coating on the top surface (in practice on both surfaces so the thread need not be oriented during manufacture, although use of a top coating only is an option). The thread

presents a machine-readable element on the surface of the note which is readily accessible to an appropriate detector. The coating is luminescent and the machine authentication involves exciting the luminescent coating with appropriate wavelengths of ultra-violet light and measuring the subsequent emitted light. Although in principle such detection would be possible with an embedded thread, there is a great practical advantage in using a windowed thread in that the intensity of stimulating light reaching the target and the intensity of emitted light from the target is much greater without the overlying absorbing region of fibre.

In reflected light the thread with its matt pale yellow coating is relatively unobtrusive and this is particularly true once the paper has been over-printed. The coating matches fairly closely the colour of the bank note paper and once the bank note is printed the windows in the paper become quite difficult to see except at certain angles where some specular reflection occurs from the surface of the thread.

In one embodiment the luminescent material in the security thread emits light in response to infra-red radiation. For instance, the luminescent material can provide infra-red radiation stimulated Anti-Stokes luminescence.

In a further embodiment of the invention the means providing at least one non-public security feature comprises an infra-red absorbent material which is provided in a chosen pattern on the security thread on at least the second part of the security thread exposed in the window, the chosen pattern being machine detectable when the security article is exposed to infra-red radiation. Preferably the infra-red absorbent material is coated with a layer of infra-red transparent material, the infra-red

transparent material having a colour which matches the portion of the first surface surrounding the window.

In one embodiment the security thread comprises thermoluminescent material at least in the second exposed part and the thermoluminescent material provides the non-public security feature.

In a further embodiment the security thread comprises triboluminescent material at least in the second exposed part and the triboluminescent material provides the non-public security feature.

In one embodiment the security article has a thread which has first and second luminescent materials with different characteristics provided on the security thread which together form the means providing at least one non-public security feature, the first and second luminescent materials having a similar appearance and colour when exposed solely to visible light.

The first and second luminescent materials can emit light of two different wavelengths and/or the two different materials can have phosphorescent decay half lives which are different. These parameters can be measured by machine.

In one embodiment the first and second luminescent materials are provided in a chosen pattern in the security thread.

In a further embodiment the security thread comprises a material provided in the security thread which reflects infra-red radiation, the infra-red reflecting material being present in the security thread in the exposed portion thereof and thereby forming the means providing at least one non-public security feature.

Alternatively, the means providing the at least one non-public security feature can comprise infra-red absorbent material provided in the security thread at least in the exposed portion thereof.

In an additional embodiment the means providing at least one non-public security feature in the security thread comprises ultra-violet reflecting material providing in the security thread at least in the exposed portion thereof. Alternatively the means providing at least one non-public security feature could comprise ultra-violet absorbent material provided in the security thread at least in the exposed portion thereof.

Preferably, in all embodiments of the security article a graphic design is applied to the first surface of the security article, the graphic design being applied to extend over and at least partially obscure the exposed part of the security thread. The present invention has as one of its advantages the fact that it frees up space on the surface of, for instance, a bank note for print designs, foils and holograms. Thus, whilst in the past the designer of a bank note had to consider the windows in the bank note when making his design, he can now consider the windows in the bank note surface as being continuous with the bank note surface and can create graphic designs which extend over the window, provided that the design does not completely obscure the window with an ink which blocks the absorption, stimulation or emission of radiation required to determine the presence of the security thread. Once these designs are printed on the bank note then the windows in the bank note are further obscured and are made less detectable. Thus, for instance, where the security article is a security paper such as a bank note, the graphic design is printed on the first surface of the security paper with the exposed part of the security thread being at least partly over- printed. In this case, the exposed part of the security thread would closely match in colour with the surrounding paper. Alternatively, the exposed part of the security thread

could closely match the colour of print on the surrounding paper.

In a second aspect the present invention provides a method of manufacture of the security article described above comprising, in any order, the steps of:

fabricating the security article with the first and second surfaces, whilst defining the window in the first surface and locating the security thread in the security article with the first part of the security thread lying between the first and second surfaces and the second part of the security thread exposed in the window;

providing a matt non-reflective surface finish on at least the exposed portion of the security thread; and

selecting the colour of the exposed portion of the security thread to match the colour of the portion of the security article surrounding the window.

When the security thread comprises a polymeric substrate then the step of selecting the colour of the exposed portion comprises selecting a coloured coating for the substrate, which colour coating is applied to the substrate to provide the colour of the surface of the exposed part of the security thread.

In a third aspect the present invention provides various methods of verifying the authenticity of the security articles mentioned above. These methods variously include:

irradiating the security article with ultra-violet light and detecting the light emitted by the luminescent material on the security thread;

irradiating the security article with infra-red radiation and measuring reflection of the infra-red radiation;

irradiating the security article with infra-red radiation and measuring absorption of the infra-red

radiation;

irradiating the security article with ultra-violet radiation and measuring reflection of the ultra-violet radiation;

irradiating the security article with ultra-violet radiation and measuring absorption of the ultra-violet radiation;

irradiating the security article with infra-red radiation and detecting light emitted by luminescent material;

irradiating the security article with infra-red radiation and detecting a pattern of absorption of the infra-red radiation;

irradiating the security article with ultra-violet radiation and measuring the wavelengths of light emitted by first and second luminescent materials on the security thread (indeed there may be more than two luminescent materials on the security thread and authentication could involve the measurement of the wavelengths of each light emitted by each material);

irradiating the security article with ultra-violet radiation and measuring the phosphorescent decay half-lives of first and second luminescent materials of the security threads (indeed there may be more than two luminescent materials on the security thread and authentication could involve the measurement of the half-life of each material);

heating the security article by exposing the security article to infra-red radiation and detecting visible light emitted by thermoluminescent material; and

applying a mechanical force to the security thread and detecting visible light emitted by triboluminescent material.

Preferred embodiments of the present invention will now be described with reference to the

accompanying drawings, in which:

Figure 1 is a schematic representation of a bank note according to one embodiment of the present invention, viewed in reflected light;

Figure 2 is a schematic view of the bank note of Figure 1, viewed in transmitted light;

Figure 3 is an illustration depicting windows in the surface of the bank note of Figures 1 and 2, which windows are not normally visible in reflected light;

Figure 4 is a cross-section through the bank note illustrated in Figures 1, 2 and 3, taken along the line A-A in Figure 3 in the direction of the arrows;

Figure 5 is a detail view of one embodiment of the invention, showing one window in a bank note;

Figure 6 is a schematic cross-section through a first embodiment of a security thread which can be used in the bank note of Figures 1 - 4;

Figure 7 is a cross-section through a second embodiment of security thread which can be used in the bank notes of Figures 1 - 4; and

Figure 8 is a schematic representation of apparatus used to test the authenticity of the bank note illustrated in Figures 1 - 4.

In Figure 1 there can be seen a bank note 10 according to a first embodiment of the present invention. The Figure shows the bank note 10 viewed in reflected light. The bank note 10 is printed over the whole of the surface of the bank note shown with a graphic design which comprises the numeral 2,000, two stripes and a human head in profile.

The bank note 10 comprises a security thread 11 which can be seen as a striking, immediately apparent, strong continuous line when the bank note 10 is viewed in transmitted light as seen in Figure 2.

The surface of the bank note 10 illustrated in Figures 1, 2 and 3 in fact comprises four windows 12, 13, 14 and 15. In these windows the thread 11 is

exposed, but between these windows the thread 11 lies between the top surface 16 of the bank note 10 and a bottom surface 17 of the bank note 10 (see Figure 4). In Figure 4 it can be seen that the security thread 11 has the four windows 12, 13, 14 and 15 in which the security thread 11 is exposed.

The security thread 11 comprises in one embodiment (see Figure 5) a polyester substrate 20 which is metallised with a metallic layer 21. Covering the metallic layer 21 is a matt pale yellow coating 22. A final external coating of transparent colourless adhesive 23 is applied over the top of the matt pale yellow coating to provide some protection to the thread and to aid and ease manufacture. A coating 24 of transparent colourless adhesive 23 is also applied to the bottom surface of the security thread 11. The matt pale yellow coating 22 matches fairly closely the appearance of the bank note paper 18 surrounding the security thread 11. Thus, the parts of the security thread visible in the windows 12, 13, 14 and 15 become quite difficult to see in reflected light, except at certain angles when some specular reflection occurs from the adhesive external coating of the security thread. For this reason, in Figure 1 the illustration of the bank note 10 shows that the windows 12, 13, 14 and 15 are not visible in reflected light. The portions of the thread 11 visible in the windows 12, 13, 14 and 15 are even less visible when the bank note paper 18 is over printed with a graphic design, as illustrated in Figure 1. Thus, the bank note is provided with a surprising optical effect in that the general public will be generally unaware of the presence of a security thread in the bank note 10 until the bank note 10 is held up to a light, when the security thread becomes visible as a dark continuous line as can be seen in Figure 2.

The security thread 11 presents a machine

readable element on the surface of the bank note 10 where it is exposed by the windows 12, 13, 14 and 15. The security thread 11 is readily accessible to an appropriate machine detector at the windows 12, 13, 14 and 15.

In the preferred embodiment the matt pale yellow coating comprises luminescent material and the machine authentication involves exciting the luminescent coating with appropriate wavelengths of ultra-violet light and then measuring the subsequent emitted light. Although in principle such detection would be possible with a fully embedded thread, there is a great practical advantage in using a windowed thread in that the intensity of the stimulating light reaching the target and the intensity of the emitted light from the target is much greater without an absorbing region of fibre overlying the security thread.

In essence the bank note 10 provides a new way of utilising windowed thread technology. Whereas in the past the windowed thread technology was used for public identification purposes primarily, now the windowed thread is used primarily for machine authentication purposes and the public effect in reflected light thought so important with existing windowed thread technology is deliberately avoided. Since the exposed portions of the security thread match the surrounding paper, the bank note of the present invention frees up space on the note surface for the printing of designs and for the affixing of foils and holograms. The bank note at the same time also maximises the signal available from a machine readable layer in or on the security thread 11. The bank note 10 also includes what becomes an unexpected effect for the general public in that the security thread 11 can be readily perceived in transmitted light.

Whilst in the embodiment described above the matt

coating is applied over the entirety of one surface of the security thread 11, in fact the matt coating could be applied selectively only in those portions which are to be exposed in the windows 12, 13, 14 and 15. Also, whilst shown above the coating material 22 is provided on only one side of the polyester substrate 20, the polyester substrate 20 could be provided with the matt coating on both sides and with adhesive top coatings on both sides, in order that the thread need not be oriented to one side only before being embedded in paper stock in the manufacture of the bank note.

The manufacture of the bank note 10 would follow the steps usual in producing windowed thread bank notes, except that the method would have the additional steps of providing a matt non-reflective surface finish on at least those portions of the security thread which will be exposed in the final bank note and the method includes the step of selecting the matt coating with a colour which matches the colour of the bank note paper.

Whilst above the colour of the matt coating is chosen to match the colour of surrounding paper, the colour of the coating could be chosen to match the colour of ink printed on the regions of the paper surrounding the windows in the paper.

Whilst above, the security thread 11 is provided with a machine measurable parameter by the use of luminescent material in the matt coating 22, other machine measurable parameters could be used. For instance, infra-red stimulated Anti-Stokes luminescent material could be used in or on the security thread at least in those portions exposed in the windows 12, 13, 14 and 15, which luminescence could then be detected by a suitable authentication machine. Alternatively, the coating 22 could be provided with infra-red reflecting or absorbing material, with the method of authentication of the bank note then comprising

analysis of the reflection/absorption of infra-red radiation by the security thread in the bank note. Similarly, ultra-violet reflecting/absorbing material could be used in the security thread 11 and then the bank note 10 irradiated with ultra-violet radiation and the reflection/absorption characteristics monitored for when verifying the authenticity of the bank note. Furthermore, thermoluminescent material could be used in the coating and this material would emit light when heated (e.g. through exposure to infra-red radiation). It is also possible to use triboluminescent material and excite the material by applying a mechanical force.

With all of these approaches, there is a benefit in having the security thread 11 exposed in the windows, since there would be no fibres of the bank note 10 which overlie the security thread 11 in these regions and thus interfere with the detection process. Furthermore, the use of a matt layer permits the use of much higher concentrations of luminescent material, infra-red reflecting/absorbing material, ultra-violet reflection/absorbing material, thermoluminescent material and/or triboluminescent material (e.g., inorganic pigments) than would be acceptable in the coating on the thread if the thread had to retain the traditionally very reflective/shiny appearance.

The applicant has considered in one embodiment printing an infra-red absorbent material in the characteristic pattern on at least portions of the security thread 11. In Figure 6 it can be seen that the polyester substrate 20 is metallised and covered with a metallic layer 21 and is then covered with the infra-red absorbent material 30 which is printed in a characteristic pattern, e.g., in alphanumeric characters. The infra-red absorbent material 30 is then covered with an overlying overcoat 31 of an infra-red transparent material of a visible colour

closely matching the colour of the surrounding bank note paper or print on the paper. Finally the infra-red transparent material would be covered with two coats 23 and 24 of transparent colourless adhesive for protection purposes. The infra-red absorbent material could for instance be printed in the numerals 2,000 and in Figure 7 there can be seen an image of a part of a bank note showing a window 12 in which the exposed part of the security thread 11 is printed with infra-red absorbent material in the numerals 2,000, the image shown in Figure 7 then being obtainable by use of suitable infra-red detecting apparatus.

In a further embodiment, a security thread can be printed with a characteristic pattern by using two or more inorganic luminescent materials of similar appearance/colour in visible light, but which emit light of different wavelengths and/or are excited by different wavelengths of excitation light and/or have different phosphorescent decay half-lives. The appearance/ colour of the luminescent materials in visible light will be chosen to match the parts of the bank notes surrounding the windows. The materials could be printed with a pattern showing alphanumeric characters, e.g., the numerals 2,000 as shown in Figure 7. The luminescent pattern is machine detectable, but could also be observed by a human observer.

In Figure 8 there can be seen a schematic drawing showing apparatus for use in the methods of authenticating bank note 10. An irradiator 40 is used to irradiate bank note 10 with, for instance, ultra-violet or infra-red radiation and the detector 41 then detects what light is emitted from and/or ultra-violet radiation and/ or infra-red radiation is reflected from the surface of the bank note 10. The detector 41 will then enable determination of either the luminescent characteristics of material in the

security thread in the bank note 10, the infra-red or ultra-violet reflecting characteristics of the security thread in the bank note 10 and/or the infra-red or ultra-violet absorbing characteristics of the security thread in the bank note 10.

Whilst above all embodiments have described use of the invention for a bank note 10, the bank note 10 is only one example of a security article for which the present invention is applicable. For instance, the present invention could be used for credit cards and debit cards, with the security thread (which terms for the purpose of this specification and claims will be interpreted as encompassing the term security strip, commonly used for cards as opposed to bank notes) partially embedded in a plastic material typically, with portions exposed at one surface. The term security article can also include any form of security paper, for instance cheques and travellers' cheques, bond documents, mortgage documents, in addition to standard bank notes used in currency.

The exposed portions of the security thread 11 could have a colour which matches the colour at the surrounding material of the security article (e.g. paper, plastics) or the colour of the printing on the portions of surface of the security article surrounding the exposed portions.

Examples of security articles incorporating the present invention will now be given, as follows:

Example 1

A roll of polyester was vacuum-metallised with aluminium to a metal thickness of approximately 30 nm. A coating comprising an inorganic phosphor, e.g. copper-doped zinc sulphide (copper:zinc sulphide ratio between 50 and 100 parts per million) dispersed in an organic binder at a proportion of 15% phosphor:binder by weight was applied to both surfaces of the metallised polyester to a dry coating thickness of 5

microns. A further organic protective coat and/or adhesive layer was applied over one or both sides of the phosphor coated metallised film. The film was then mechanically reduced by known means to form security threads in the width range typically 0.5 -4.0 mm. The security threads were then incorporated into banknote paper by the known technique described in EP-A-0059056 to form a windowed security thread. The paper was then printed, cut and issued as banknotes.

The coating has a pale yellow colour in daylight which closely matches that of the paper into which the thread is incorporated. The threads and the coated film from which the threads are cut have a matt appearance. The matt appearance of the coated film was characterised by one of several techniques as follows:-

(i) The gloss of the coated film was measured on a statistical Novo-Gloss 60° glossmeter with an upper limit of 1000 gloss units (theoretical perfect mirror). The coated film had a gloss measurement of 31 units; this compares with vacuum-metallised film with an identical adhesive coat which, on the same instrument, measured 497 gloss units.

(ii) The gloss of the same film was measured on a multi-angle Novo-Gloss glossmeter at 20°, 60° and 75° angle. This unit has an upper limit of 199 gloss units. The measurements were as shown in the following table:

Sample	Angle	Head Average gloss
Metallised film with luminescent coating and adhesive coating	20° 60° 75°	5.8 31.0 73.0
Adhesive coated metallised polyester	20° 60° 75°	>199 >199 >199

(iii) The specular reflectance was measured on a Shimadzu UV3101-PC spectrophotometer. The sample comprising a luminescent coating plus adhesive coating on metallised polyester produced measurements ranging from 0.8% at 400nm to 1.6 at 700nm; the adhesive-coated metallised polyester produced a value ranging from 50% at 400nm to 58% at 700 nm.

Under stimulation by UV light at a wavelength of 366 nm, the coating emitted green light. Other phosphors may be used, e.g. manganese-doped zinc sulphide, which emits orange light and silver-doped zinc sulphide which emits blue light.

During subsequent used note sorting operations, the banknotes were carried by a transport path through a detection unit comprising a UV light source and optical filter tuned to the emission wavelength of the doped zinc sulphide and an appropriate photodetector.

Example 2

A dispersion of magnetic material (gamma ferric oxide) in an organic binder was coated to a dry film thickness of 5μm onto the metallised surface of a vacuum aluminised 12μm thick polyester. A second ply of vacuum aluminised 12μm polyester was laminated to the first ply such that both aluminium layers and the magnetic layer were internal to the laminate. A coating of luminescent material comprising copper-doped zinc sulphide in an organic binder was applied

to each side of the laminate, to a dry thickness of 5μm. The film was then adhesive-coated on both sides and processed as described in Example 1. During subsequent used note sorting operations, both the phosphorescent emission and magnetic content of the security thread were measured according to known techniques by appropriate detectors fitted to the sorting machine transport path.

Example 3

A layer of copper-doped zinc sulphide pigment incorporated into an organic binder at a proportion of 5% by weight was coated to a dry thickness of 2μm onto transparent 12μm polyester. A layer of transparent adhesive was applied to each side to a dry thickness of 4μm and the film converted to security threads as described in Example 1. In contrast to the devices described in Examples 1 and 2, this thread is semi-transparent and not readily apparent in the finished article when viewed in transmitted light. In use, the presence of the luminescent coating may be determined by a machine, as described in Example 1, or by a human observer when the luminescent component is excited by placing the article under a source of UV light or between a source of UV light and the observer.

Example 4

As Example 1, except that two different doped zinc sulphide phosphors were incorporated into the organic binder in equal proportions to produce a combined weight of 15% pigment:binder. In use, the different phosphors emitted different wavelengths of light which were detected by photo-detectors fitted with appropriate narrow band optical filters tuned to the emission wavelengths of the two phosphors.

Example 5

A security thread was prepared as described in Example 4 except that in this instance phosphors with different half-life decay times were used. To

authenticate banknotes incorporating the thread, measurements were made of the different decay properties of the two phosphors.

Example 6

As Example 1, except that a different zinc phosphor was used with a pale blue colour in visible light, chosen to match the colour of the surrounding ink in the finished banknote prepared from the paper incorporating the security thread.

Example 7

As Example 1, except that a fluorophor was used instead of an inorganic phosphor as the luminescent pigment. A fluorescence rather than phosphorescence detector was then used to authenticate the banknote on the sorting machine transport system.

Example 8

As Example 3, except that a lightly coloured IR absorbing pigment, e.g. substituted chloro copper pH Halo cyanine, trade name PROJECT 900NP from the Zeneca company, was incorporated into an organic binder at proportion of 5% pigment binder and used for the coating over the transparent polyester to a dry coating thickness of 2 microns. In use on used note sorting machines, measurement was made of the IR peak of 890nm absorption due to the pigment which contrasted sharply with the IR transmission of the surrounding areas of the security article.

Example 9

As Example 1, except that an Anti-Stokes pigment such as yttrium oxysulphide was incorporated into the binder in place of the zinc sulphide phosphor at a concentration of 30% pigment:binder and applied at a dry coating thickness of 2 microns. To authenticate the finished banknote, it was placed under a source of IR radiation at 970nm which excited the Anti-Stokes compound which then emitted green light at a wavelength of 540nm discernible to a human observer.

Example 10

As Example 1, except that a thermoluminescent pigment was incorporated into the binder instead of the zinc sulphide phosphor. In use, the security article was heated by an IR source or other heat source and the thermoluminescent material emitted visible light which was detected by a photo-detector equipped with a suitable narrow band optical filter.

Example 11

A manganese-doped zinc sulphide phosphor (manganese content 3000 parts per million) was dispersed in an organic binder at a proportion of 30% pigment:binder and coated onto one side of a 12 micron metallised polyester film to produce a triboluminescent coating. The other side of the film was coated with an adhesive and the film reduced by mechanical means to dimensions suitable for a banknote security thread, e.g. 1-4mm. The thread was inserted into paper according to the process described in EP 0059056 such that the side of the film coated with the phosphor and binder was exposed in the window regions. The paper was then printed, cut and issued as banknotes. The colour of the ink in the window region of the banknote was selected to match closely that of the phosphor/binder coating such that the presence of the windowed security thread was not readily discernible in reflected light.

In use, the phosphor coating was stimulated by mechanical action such as rubbing or pressing the surface with a hard transparent plastic rod. The phosphor exhibited triboluminescent properties and emitted visible light which was discernible to the human eye.

CLAIMS:

1. A security article having first and second surfaces and a security thread having a first part located between the first and second surfaces and a second part exposed in a window provided in the first surface, and the security thread comprising means providing at least one non-public security feature which enables verification of authenticity of the security article and which is not visually detectable when the security thread is exposed only to electromagnetic radiation in the visible spectrum, wherein the exposure of the second part of the security thread in the window in the first surface enhances detection of the non-public security feature by providing a readily accessible portion of the security thread, characterised in that the whole of the part of the security thread exposed in the window in the first surface has a matt non-reflective appearance and closely matches in colour a portion of the first surface surrounding the window, whereby when the first surface is viewed in reflected light in the visible spectrum the exposed part of the security thread is unobtrusive and does not form a visually striking feature of the appearance of the security article in reflected light in the visible spectrum.

2. A security article as claimed in claim 1 wherein at least one non-pubic security feature is a machine measurable security feature and the exposure of the second part of the security thread in the window enhances measurement of the machine measurable security feature.

3. A security article as claimed in claim 1 or claim 2 which comprises material which allows transmission of light between the first and second surfaces and wherein the

security thread is visible in such transmitted light.

4. A security article as claimed in claim 1 or claim 2 which comprises material which allows transmission of light between the first and second surfaces and wherein the security thread is nearly transparent and is not readily visible in transmitted light.

5. A security article as claimed in any one of the preceding claims wherein the non-public security feature is detected by exposing the second exposed part of the security thread to electromagnetic radiation outside of the visible spectrum.

6. A security article as claimed in claim 5 wherein the security thread emits electromagnetic radiation when exposed to the electromagnetic radiation outside of the visible spectrum.

7. A security article as claimed in claim 6 wherein the emitted electromagnetic radiation is in the visible region of the electromagnetic spectrum.

8. A security article as claimed in any one of the preceding claims wherein the surface of the security thread exposed in the window in the first surface of the security article has a gloss of 50 units or less as measured by a Novo-Gloss 60° glossmeter.

9. A security article as claimed in any one of the preceding claims wherein the surface of the security thread exposed in the window in the first surface of the security article has a gloss of 10 units or less as measured by a multi-angle Novo-Gloss glossmeter operating at 20°.

10. A security article as claimed in any one of the

preceding claims wherein the surface of the security thread exposed in the window in the first surface of the security article has a gloss of 50 units or less as measured by a multi-angle Novo-Gloss glossmeter operating at 60°.

11. A security article as claimed in any one of the preceding claims wherein the surface of the security thread exposed in the window in the first surface of the security article has a gloss of 120 units or less as measured by a multi-angle Novo-Gloss glossmeter operating at 75°.

12. A security article as claimed in any one of the preceding claims wherein the surface of the security thread exposed in the window in the first surface of the security article has a specular reflectance of 5.0% or less as measured by a Shimadzu UV3101-PC spectrophotometer operating in a range of 400-700 nm.

13. A security article as claimed in any one of the preceding claims wherein the security thread comprises a metallised polymeric substrate coated at least in the exposed portion with a matt coating obscuring the metal in the thread.

14. A security article as claimed in claim 12 wherein the metallised polymeric substrate is opaque.

15. A security article as claimed in claim 13 or claim 14 wherein the matt coating is luminescent and provides non-public security feature of the security thread by emitting measurable light when exposed to ultra-violet radiation.

16. A security article as claimed in any of the

preceding claims wherein the security thread comprises luminescent material which constitutes the means providing at least one non-public security feature by providing detectable luminescence at the exposed part of the security thread.

17. A security article as claimed in claim 16 wherein the luminescent material emits visible light in response to infra-red radiation.

18. A security article as claimed in claim 17 wherein the luminescent material provides infra-red radiation stimulated Anti-Stokes luminescence.

19. A security article as claimed in any one of the preceding claims wherein the means providing at least one non-public security feature comprises an infra-red absorbent material which is provided in a chosen pattern on the security thread on at least the second part of the security thread exposed in the window, the chosen pattern being machine detectable when the security article is exposed to infra-red radiation.

20. A security article as claimed in claim 19 wherein the infra-red absorbent material is coated with a layer of infra-red transparent material, the infra-red transparent material having a colour which matches the portion of the first surface surrounding the window.

21. A security article as claimed in any one of the preceding claims wherein the security thread comprises thermoluminescent material at least in the second part thereof exposed in the window, the thermoluminescent material forming the means providing at least one non-public security feature.

22. A security article as claimed in any one of the preceding claims wherein the security thread comprises triboluminescent material at least in the second part thereof exposed in the window, the triboluminescent material forming the means providing at least one non-public security feature.

23. A security article as claimed in any one of the preceding claims wherein first and second luminescent materials with different characteristics are provided on the security thread, which together form the means providing at least one non-public security feature, the first and second luminescent materials having a similar appearance and colour when exposed solely to visible light.

24. A security article as claimed in claim 23 wherein the first luminescent material emits light of a first wavelength and the second luminescent material emit light of a second wavelength different to the first wavelength.

25. A security article as claimed in claim 23 or claim 24 wherein the first luminescent material has a phosphorescent decay half-life of a first duration and the second luminescent material has a phosphorescent decay half-life of a second duration different to the first duration.

26. A security article as claimed in any one of claims 23 to 25 wherein the first and second luminescent materials are provided in a chosen pattern on the security thread.

27. A security article as claimed in any one of claims 23 to 26 which has at least three luminescent materials with different characteristics to each

other.

28. A security article as claimed in any one of the preceding claims, wherein the security thread comprises a material provided which reflects infra-red radiation, the infra-red reflecting material being present in the security thread in the exposed portion thereof and thereby forming the means providing at least one non-public security feature.

29. A security article as claimed in any one of the preceding claims wherein the security thread comprises infra-red absorbent material provided in the security thread at least in the second exposed part thereof, the infra-red absorbent material forming the means providing at least one non-public security feature.

30. A security article as claimed in any one of the preceding claims wherein the means providing the at least one non-public security feature comprises ultraviolet reflecting material in the security thread at least in the exposed portion thereof.

31. A security article as claimed in any one of the preceding claims wherein the means providing at least one non-public security feature comprises ultra-violet absorbent material provided in the security thread at least in the exposed portion thereof.

32. A security article as claimed in any one of the preceding claims wherein a graphic design is applied to the first surface of the security article, the graphic design being applied to extend over and at least partially obscure the exposed part of the security thread.

33. A security article as claimed in claim 32 wherein the security article is a security paper such as a

banknote, the graphic design being printed on the first surface of the security paper with the exposed part of the security thread being at least partly over-printed.

34. A security paper as claimed in claim 33 wherein the colour of the exposed part of the security thread closely matches the surrounding paper.

35. A security paper as claimed in claim 33 wherein the colour of the exposed part of the security thread matches the colour of print on the surrounding paper.

36. A method of manufacture of the security article claimed in any one of the preceding claims comprising, in any order, the steps of:

fabricating the security article with the first and second surfaces whilst defining the window in the first surface and locating the security thread in the security article with the first part thereof lying between the first and second surfaces and the second part exposed in the window;

providing a matt non-reflective surface finish on at least the exposed portion of the security thread; and

selecting the colour of the exposed portion of the security thread to match the colour of the portion of the security article surrounding the window.

37. A method as claimed in claim 36 wherein the security thread comprises a polymeric substrate and the step of selecting the colour of the exposed portion comprises selecting a coloured coating for the substrate, which coloured coating is applied to the substrate to provide the colour of the surface of the exposed part of the security thread.

38. A method of verifying authenticity of the security article claimed in claim 15 or claim 16 comprising the steps of:

irradiating the security article with ultra-violet light; and

detecting the light emitted by the luminescent material.

39. A method of verifying authenticity of the security article claimed in claim 28 comprising the steps of:

irradiating the security article with infra-red radiation; and

measuring reflection of the infra-red radiation.

40. A method of verifying authenticity of the security article claimed in claim 29 comprising the steps of:

irradiating the security article with infra-red radiation; and

measuring absorption of the infra-red radiation.

41. A method of verifying authenticity of the security article claimed in claim 30 comprising the steps of:

irradiating the security article with ultra-violet radiation; and

measuring reflection of the ultra-violet radiation.

42. A method of verifying authenticity of the security article claimed in claim 31 comprising the steps of:

irradiating the security article with ultra-violet radiation; and

measuring absorption of the ultra-violet radiation.

43. A method of verifying authenticity of the security article claimed in claim 18 comprising the steps of:

irradiating the security article with infra-red radiation; and

detecting the light emitted by the luminescent material.

44. A method of verifying authenticity of the security article claimed in claim 19 or claim 20 comprising the steps of:

irradiating the security article with infra-red radiation; and

detecting the pattern of absorption of the infra-red radiation.

45. A method of verifying authenticity of the security article claimed in claim 24 comprising the steps of:

irradiating the security article with ultra-violet radiation; and

measuring the wavelengths of the light emitted by the first luminescent material and the wavelength of the light emitted by the second luminescent material.

46. A method of verifying authenticity of the security article claimed in claim 25 comprising the steps of:

irradiating the security article with ultra-violet light; and

measuring the phosphorescent decay half lives of the first and second luminescent materials.

47. A method of verifying authenticity of the security article claimed in claim 21 comprising the steps of:

heating the security article by exposing the security article to infra-red radiation; and

detecting visible light emitted by the thermoluminescent material.

48. A method of verifying authenticity of the security article claimed in claim 22 comprising the steps of:

applying a mechanical force to the security thread; and

directing visible light emitted by the triboluminescent material.

49. A security article substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

22556/02

Application No: GB 9711469.8 **Examiner:** Graham Russell
Claims searched: 1-49 **Date of search:** 18 August 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B6A (ATC)

Int Cl (Ed.6): B42D 15/00

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 4941687 (CRANE) see column 1 lines 55-60	1,36

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.